Baseline Programs

Chapter 2

This chapter presents the Department's consolidated, baseline program for the management of nuclear materials. For ease in presentation, the baseline program is organized into four major material categories: plutonium, uranium, spent nuclear fuel, and other nuclear materials. These material groupings have unique characteristics, technical considerations, and disposition plans.

An overview of each material category's inventory, disposition strategy, and key associated facilities is provided in this chapter. Table 2-1 depicts decisions made under NEPA and ongoing NEPA reviews, DNFSB Recommendations and Implementation Plans, and other analyses that drive the way the Department manages these materials. Also discussed in this chapter are areas that cut across all material types such as facilities, transportation, and technology. The chapter closes with a presentation on the distribution of Departmental funding by program, materials management function, and material type.

Table 2-1 Nuclear Materials Management Implementation Drivers

	Plutonium	Uranium	Spent Nuclear Fuel	Other Nuclear Materials
Decisions Under NEPA				
Record of Decision for the Surplus Plutonium Disposition Final Environmental Impact Statement (DOE, 2000a)	✔			
Record of Decision for Long-Term Management and Use of Depleted Uranium Hexafluoride (DOE, 1999g)		✔		
Records of Decision on the Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site (DOE, 1998a, 1999a, 1999e)	✔			
Record of Decision for the Storage and Disposition of Weapons-Usable Fissile Materials (DOE, 1997a)	✔			
Records of Decision for the Final Environmental Impact Statement for a Dry Storage Container System for the Management of Naval Spent Nuclear Fuel (DOE, 1997f, 1997g)			✔	
Record of Decision for the Stockpile Stewardship and Management Programmatic Environmental Impact Statement (DOE, 1996i)	✔	✔		
Record of Decision for the Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement (DOE, 1996c)		✔		
Record of Decision for the Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel (DOE, 1996b)			✔	
Records of Decision on Interim Management of Nuclear Materials at the Savannah River Site (DOE, 1995d, 1996d, 1996h, 1997e)	✔	✔	✔	✔
Records of Decision on Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs (DOE, 1995b, 1996a)			✔	
Ongoing NEPA Reviews				
Management of Spent Nuclear Fuel at the Savannah River Site (Final Environmental Impact Statement - DOE, 2000d)			✔	
Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility [Notice of Intent (NOI)-DOE, 1999i]	✔			✔
Treatment and Management of Sodium Bonded Spent Nuclear Fuel (Draft Environmental Impact Statement - DOE, 1999d)			✔	
Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain (Draft Environmental Impact Statement – DOE, 1999h)	✔	✔	✔	✔
Site-Wide Environmental Impact Statement, Oak Ridge Y-12 Plant (NOI - DOE, 1999c)		✔		
DNFSB Recommendations and Associated DOE Implementation Plans				
Recommendation 2000-1, Follow-on to Recommendation 94-1, Improved Schedule for Remediation in the Defense Nuclear Complex (DNFSB, 2000); Implementation Plan (DOE, 2000b)	✔	✔	✔	✔
Recommendation 99-1, Safe Storage of Pits at Pantex (DNFSB, 1999b); Implementation Plan (DOE, 2000c)	✔			
Recommendation 98-2, Safety Management at the Pantex Plant (DNFSB, 1998); Implementation Plan (DOE, 1999l)	✔			
Recommendation 97-2, Continuation of Criticality Safety at Defense Nuclear Facilities (DNFSB, 1997b); Implementation Plan (DOE, 1998d)		✔		
Recommendation 97-1, Safe Storage of Uranium-233 (DNFSB, 1997a); Implementation Plan (DOE, 1997c)		✔		
Recommendation 94-1, Improved Schedule for Remediation in the Defense Nuclear Complex (DNFSB, 1994); Implementation Plan (DOE, 1995f, 1998b, and 2000b)	✔	✔	✔	✔
Other				
DOE Standard 3013, Stabilization, Packaging, and Storage of Plutonium-Bearing Materials (DOE, 1999k)	✔			
FY 2000 Stockpile Stewardship Plan (Executive Overview) (DOE, 1999b)	✔	✔		
SRS Chemical Separation Facilities Multi-Year Plan (DOE, 1997b)	✔	✔	✔	✔
HEU Working Group Report on Environmental, Safety, and Health Vulnerabilities Associated with Storage of HEU (DOE, 1996e)		✔		
Y-12 Environmental Assessment/Finding of No Significant Impact (DOE, 1995g)		✔		
Settlement Agreement between DOE, U.S. Navy, and the State of Idaho (Public Service Company of Colorado vs Batt) (PSC, 1995)			✔	
Plutonium Working Group Report on Environmental, Safety, and Health Vulnerabilities Associated with the Department's Plutonium Storage (DOE, 1994)	✔			✔
Spent Nuclear Fuel Working Group Report on Inventory and Storage of the Department's Spent Nuclear Fuel and Other Reactor Irradiated Nuclear Materials and their Environmental, Safety, and Health Vulnerabilities (DOE, 1993)			✔	

Plutonium

Overview and Inventories

Stabilized plutonium metals and oxides are stored in special storage cans, known as "3013 Cans."

Plutonium is a manmade fissile element. Pure plutonium is a silvery metal, heavier than lead. Material rich in the Pu-239 isotope is preferred for manufacturing nuclear weapons. The half-life of Pu-239 is 24,000 years. From the early 1940's to the late 1980's, the U.S. Government produced plutonium for its nuclear weapons stockpile and research and development programs. The process involved neutron bombardment of uranium in production reactors at the Hanford and Savannah River sites and chemical processing in facilities at these same sites to produce purified plutonium products, generally metal. Metal for weapons was then sent to Rocky Flats to be made into weapons parts (including pits). These weapons parts were then shipped to Pantex for assembly into nuclear weapons. Rocky Flats was also required to conduct a large amount of processing for purification and recovery of the weapons parts that came back from weapons dismantlement/retirement activities at Pantex.

These production and processing activities, geared to high output, produced a large quantity of leftover materials: metal scrap, oxides, solutions, and waste forms still containing significant amounts of plutonium. With the cessation of weapons production, many plutonium forms were left in in-process conditions without defined recovery or stabilization paths. Additionally, many of these former production facilities still exist and are in use today for stabilization and disposition activities. These facilities are, in many cases, old and possess inadequate storage capacities for surplus plutonium materials.

Currently, the Department manages approximately 99.5 MT of plutonium, consisting of several different isotopes, the predominant isotope of which is Pu-239 (see Figure 2-1). A large portion of this weapons-capable plutonium is used by national security programs managed by DOE and the Department of Defense (DoD). National security plutonium material is used in the nuclear weapons stockpile and material held for reserves at Pantex, or used for process development and research and development at the two weapons design laboratories, LANL and LLNL. It also includes material that is part of mutual defense activities to support U.S. Government agreements to hold, exchange, or otherwise manage nuclear material in cooperation with our allies to provide for enhanced national security of the United States and its allies.

Of the total plutonium managed by the Department, 52.5 MT are excess to national security needs (see Figure 2-2). Most of this material is in the form of excess pits (for weapons) and fuel. A small portion of the 52.5 MT supports programmatic uses such as basic scientific research, criticality research, and production of medical isotopes. Most of this is in the form of fuel for the Zero Power Physics Reactor (ZPPR) and Fast Flux Test Facility (FFTF). The majority of the excess, approximately 48 MT, has no programmatic need. This material is located at seven major sites and is in a variety of physical forms and purity levels. These materials are packaged in cans, pins, plates, drums, or combinations thereof. Table 2-2 provides a summary of the Department's approach for plutonium management.

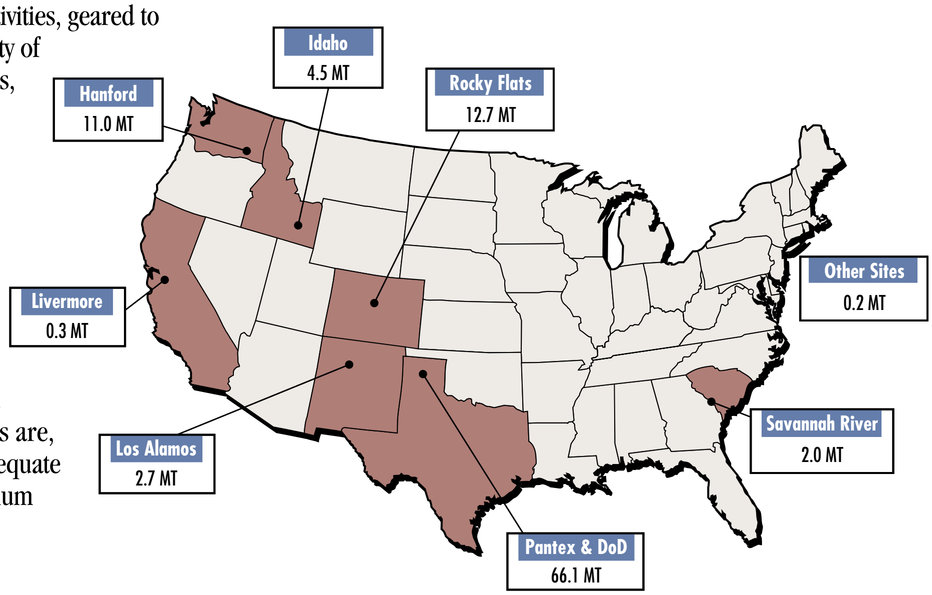
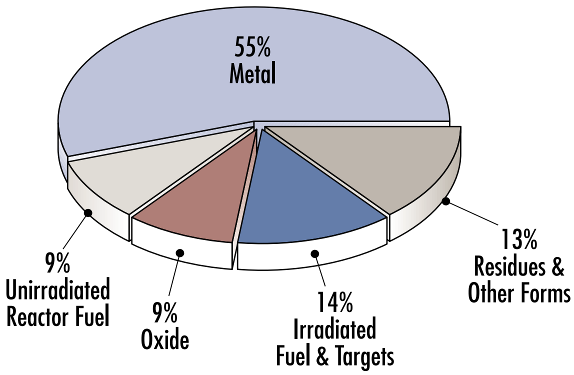


Figure 2-1 Plutonium Inventories by Site (Based upon the Secretary of Energy's *Openness Initiative* Announcement of February 6, 1996.)

Figure 2-2 Forms of Plutonium Excess to National Security Needs



Baseline Program

Continued National Security and Non-National Security Programmatic Uses. The major portion of national security plutonium will remain in the weapons stockpile and associated strategic reserve. Smaller quantities are required by various elements of the Stockpile Stewardship Program to support continued maintenance of the U.S. weapons stockpile. The Stockpile Stewardship Program is documented in the annual updates to the classified Stockpile Stewardship Plan prepared by the Office of Defense Programs in the National Nuclear Security Administration (DOE, 1999b). The Department's policy is to eliminate, where possible, the stockpiles of plutonium and ensure the highest standards of safety and accountability. The United States prohibits production of plutonium for nuclear explosives purposes, or outside of international safeguards. The United States also makes available fissile material no longer needed for our national security purposes to safeguarding by the IAEA, consistent with plans for treatment, storage, and disposition.

Non-national security programmatic reserve material is used to support programmatic uses other than national security, such as basic science research, criticality, or manufacturing heat sources. The Department's strategy for non-national security programmatic Pu-239 is to store the plutonium-based fuels safely pending potential future uses (i.e., fuel for the FFTF and ZPPR). If a decision were made to restart the FFTF, the inventory of unirradiated FFTF mixed uranium-plutonium oxide fuel currently being stored at Hanford would be used to fuel and operate the FFTF. If the reactor were deactivated, the unirradiated MOX fuel would be appropriately dispositioned. The Department is now considering retaining the ZPPR fuel as a national resource at ANL–W. The Department is currently preparing a Programmatic Environmental Impact Statement (PEIS) (DOE, 1999i) to consider the potential impacts of expanded nuclear facilities to accommodate new civilian nuclear energy research and development efforts and isotope production missions, including the role of the FFTF. The balance of the programmatic plutonium is in small research quantities and sealed sources, and those uses are discussed together with other nuclear materials later in the chapter.

Surplus Plutonium Stabilization and Storage – Surplus plutonium material includes inventories that have no identified programmatic needs. These materials exist in a range of forms and purities (primarily as metals, oxides, and residues). While the plutonium materials discussed are generally in stable forms and do not require processing, much of the surplus plutonium materials are not in safe forms for long-term storage. Improperly stored Pu-239 poses a variety of hazards. When containers or packagings fail to fully protect plutonium metal from exposure to air, oxidation can occur and cause packaging failures and personnel contamination. Contamination can also occur when plutonium solutions leak from tanks or piping. Plutonium in the form of scrap materials or residues generated by weapons production is often very

Table 2-2 Plutonium Management Approach

Pu Material	Storage and Stabilization	Disposition
Weapons Stockpile	• Maintain in weapons stockpile and associated reserve – Surveillance – Assessment and certification – Design and manufacturing (refurbish and certify)	• Use for national security
Programmatic (Non-National Security)	• Store pending future use	• FFTF fuel use is contingent upon decisions in PEIS/Record of Decision
Excess or Surplus	• Repackage pits for safe storage (address DNFSB Recommendation 99-1) • Stabilize and repackage metals and oxides for safe storage (address DNFSB Recommendations 94-1 and 2000-1); process at-risk fuel and targets at SRS • Consolidate plutonium storage • Improve SRS storage capacity (K-Area Material Storage and Building 235-F)	• Repackage (stabilize and blend as needed) plutonium residues for disposal at the Waste Isolation Pilot Plant (WIPP) • Dispose of spent nuclear fuel (containing plutonium) in a monitored geologic repository • Pursue hybrid approach for surplus plutonium: – Immobilize plutonium in ceramic material with high-level waste for geologic disposal – Irradiate as MOX fuel in domestic, commercial reactors (with spent fuel prepared for a monitored geologic repository)

corrosive, chemically reactive, and difficult to contain. Buildings and equipment that are aging, poorly maintained, or of obsolete design contribute to the overall problem.

The DNFSB has urged the Department to expedite stabilization of its surplus plutonium materials (Recommendations 94-1 and 2000-1) (DNFSB, 1994 and 2000). The Department is in the process of repackaging pits and is actively repackaging metals and oxides to place them in safe conditions — either in special packaging that meets standards for long-term storage or in packages suitable for disposal at WIPP.

In accordance with its Record of Decision on the Storage and Disposition of Weapons-Usable Fissile Materials (DOE, 1997a), the Department will consolidate surplus non-pit plutonium at SRS from Rocky Flats to facilitate closure of facilities. Previous plans had anticipated construction of a new Actinide Packaging and Storage Facility (APSF) at SRS to provide the needed storage capacity. Recent analyses have determined that a preferred approach would be to use existing storage capabilities at SRS [K-Area Material Storage (KAMS) and Building 235-F]. These facilities will require upgrade or expansion. Detailed discussion of this topic is found in Chapter 3.

Surplus Plutonium Disposition – The fundamental purpose of the program is to maintain a high standard of security and accounting for these materials while in storage, and to ensure that plutonium declared excess to national security needs (now, or in the future) is not used for nuclear weapons. On January 11, 2000, the Department issued its Record of Decision for the Surplus Plutonium Disposition Final Environmental Impact Statement (EIS) (DOE, 2000a), affirming an earlier decision to pursue a hybrid approach for disposition of surplus plutonium and selecting SRS as the location for the facilities. The hybrid approach uses both immobilization and MOX fuel technologies and will require construction of three facilities at SRS:

- A pit disassembly and conversion facility (PDCF) will be used to disassemble nuclear weapons pits and to convert the metal (along with other non-pit pure metal) to a declassified oxide form suitable for international inspection. The resultant oxide would either be used as feedstock for MOX fuel or be immobilized for direct disposal with HLW in a geologic repository.
- A facility to fabricate MOX fuel for irradiation in existing, domestic commercial reactors. Following irradiation, the spent nuclear fuel will be shipped to a geologic repository for disposal.
- An immobilization facility to convert plutonium stocks not suitable for reactor fuel to a ceramic form that would then be sealed in cans and placed in empty HLW canisters using the "can-in canister" concept. The canisters will be transported to the existing Defense Waste Processing Facility (DWPF) to be filled with borosilicate glass containing HLW. The canisters will eventually be shipped to a geologic repository for disposal, along with Departmental and commercial spent nuclear fuel.

Approximately 3 MT of plutonium in residues, primarily at Rocky Flats, will be repackaged (with stabilization and blending down, as needed) and shipped to WIPP for disposal as TRU waste. The remainder of the Rocky Flats residues and scrub alloy will be sent to SRS for processing and storage until final disposition. These residues were addressed in the Records of Decision concerning the management of Rocky Flats plutonium residues and scrub alloy (DOE, 1998a, 1999a, 1999e). About 7.5 MT of plutonium, in the form of spent nuclear fuel, is expected to be disposed of intact in a geologic repository. The only exception is a very small quantity of plutonium present in damaged targets and fuels scheduled for processing at SRS. Depending on the fuel type, this small quantity of plutonium will either be processed into plutonium metal for disposition or dispositioned as an HLW stream.

In sum, the end state for all surplus plutonium is geologic disposal (either WIPP or an HLW geologic repository). See Table 2-3 for an overview of key plutonium facilities. Figure 2-3 shows the amounts of Pu-239 that are to be dispositioned as discussed earlier, and Figure 2-4 presents the current status of the complex as it pertains to sites storing plutonium awaiting disposition.

"Can-in Canister" concept for immobilized plutonium

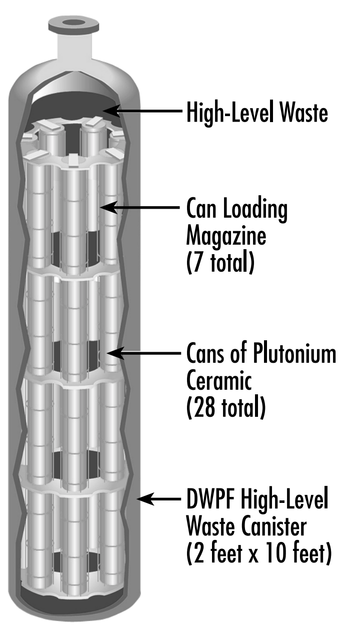


Table 2-3 Key DOE Plutonium Facilities

Facilities	Site	Function	Status
TA-55/PF-4, Plutonium	LANL	• Research and development (R&D) supporting stockpile stewardship (incl. pit rebuild) • Stabilization, packaging and storage of surplus residues, metal, and oxide • Development and testing supporting disposition of surplus plutonium	• Stewardship activities ongoing (e.g., plutonium aging, pit rebuild) • Stabilization of residues underway • PDCF Advanced Recovery and Isotope Extraction System (ARIES) work continues supporting facility design
New Chemistry and Metallurgy Research Facility	LANL	• R&D - Analytical Chemistry • R&D - Engineering and Design Support • R&D - Metallurgy • Remote Operations	• Proposed facility to begin Operation in 2010, subject to NEPA review
Facility (B332)	LLNL	• R&D supporting science-based stockpile stewardship • Development and testing supporting disposition of surplus plutonium • Development of methods to survey and monitor Pu for international inspection	• Stabilization of metals and oxides beginning at LLNL • Pu immobilization disposition development work continues • Pit Disassembly and Conversion testing continues • Advanced Pu monitoring technique development ongoing
Zone 4	Pantex	• Current storage of surplus and national security pits • Pit surveillance in support of science-based stockpile stewardship • Future storage of surplus pits	• Pit storage and surveillance activities ongoing
Zone 12	Pantex	• Current storage of surplus and national security pits • Repackaging of pits • Disassembly of weapons components • Future storage of national security pits	• Disassembly ongoing in concert with pit rebuild and other stockpile stewardship activities • Repackaging of pits underway
Fuel Manufacturing Facility, Zero Power Physics Reactor	ANL-W	• Storage of Pu ZPPR fuel	• Fuel in storage pending future use
F- and H-Canyons/FB-Line, HB-Line	SRS	• Processing of at-risk fuel and targets; stabilization of Pu-239 residues	• Pu-239 stabilization ongoing in canyon facilities and HB/FB lines
Existing storage facilities (K-Area Materials Storage and 235-F)	SRS	• Storage	• Pu-239 material in storage in 235-F vault • K-Area was recently modified to store surplus metal and oxide pending disposition; scheduled to start receiving material from Rocky Flats in Fall 2000
New Pit Disassembly and Conversion Facility	SRS	• Disassembly of pits and convert to unclassified oxide product	• January 2000 Record of Decision selected SRS as site • Design work has been initiated
New Plutonium Immobilization Facility	SRS	• Conversion of non-pit Pu into oxide and encapsulation into ceramic matrix for disposal	• January 2000 Record of Decision selected SRS as site • Design work scheduled to begin 2001
New MOX Fabrication Facility	SRS	• Fabrication of MOX fuel from oxide	• January 2000 Record of Decision selected SRS as site • Design work has been initiated
Plutonium Finishing Plant Complex	Richland (RL)	• Stabilization, packaging, and storage of plutonium metal, oxide, and residues • Storage of miscellaneous fuel materials	• Planning for remaining stabilization and packaging work essentially complete • Stabilization work on oxides has been initiated
400 Area (in/near Fast Flux Test Facility)	RL	• Storage of FFTF fuel	• Ongoing storage pending decision under NEPA on use/disposition of FFTF fuel
Building 707	Rocky Flats Environmental Technology Site (RFETS)	• Stabilization, packaging, and storage of plutonium residues	• Stabilization for interim storage continues • Completion targeted for May 2002 • Other facilities continue packaging of waste for disposal
Building 371	RFETS	• Stabilization, packaging, and storage of plutonium metals, oxides, and residues	• Pu stabilization and packaging system is scheduled to package metals and oxides to long-term storage standards in Fall 2000

Figure 2-5 provides a summary representation of the major paths in the Department's current baseline program to accomplish its plutonium missions. The following discussion presents some of the key issues faced in implementing the baseline program.

- When certain operations ceased at the end of the Cold War, plutonium materials were temporarily left in unstable conditions.
  - Residues stabilization schedules are slipping, risks need to be more fully understood, and uncertainty reduces the accuracy of estimated costs.
  - Each site/facility is planning, somewhat independently, for storage capacity necessary to meet near-term programmatic needs. More comprehensive and integrated evaluations are needed to identify storage needs.
- National security and nonproliferation work at the national laboratories may be impeded by space constraints. For example, increased space is needed for materials used to design, develop, and verify instrument performance.
- There is a significant need to establish functions in support of Science-Based Stockpile Stewardship and to replace the fabrication functions previously performed at Rocky Flats. Approximately 50 percent of the nation's plutonium will be managed in this path. Historical capabilities, capacities, and technologies are essentially obsolete and are in need of replacement. Component fabrication technology must be upgraded and new certification capability must be established.
- Nonproliferation programs require materials for access, monitoring, instrument development, and advanced monitoring research, some of which are dependent on plutonium.
- The Department will dispose of approximately 50 percent of the plutonium and simultaneously use these quantities to negotiate a reduction in the inventory of Russian-held plutonium. New facilities are needed to accomplish this mission.
- Increased integration is needed for the design, certification, procurement, and management of shipping containers, Department-wide.
- Finally, improved planning and management integration is needed among sites and Departmental offices to meet mission requirements (e.g., transportation, safety, storage, waste criteria). A more corporate level, comprehensive vision and plan for management of the Department's inventory of plutonium is needed to meet all Department objectives.

Figure 2-3 U.S. Excess Plutonium by Material Type and Disposition Pathway

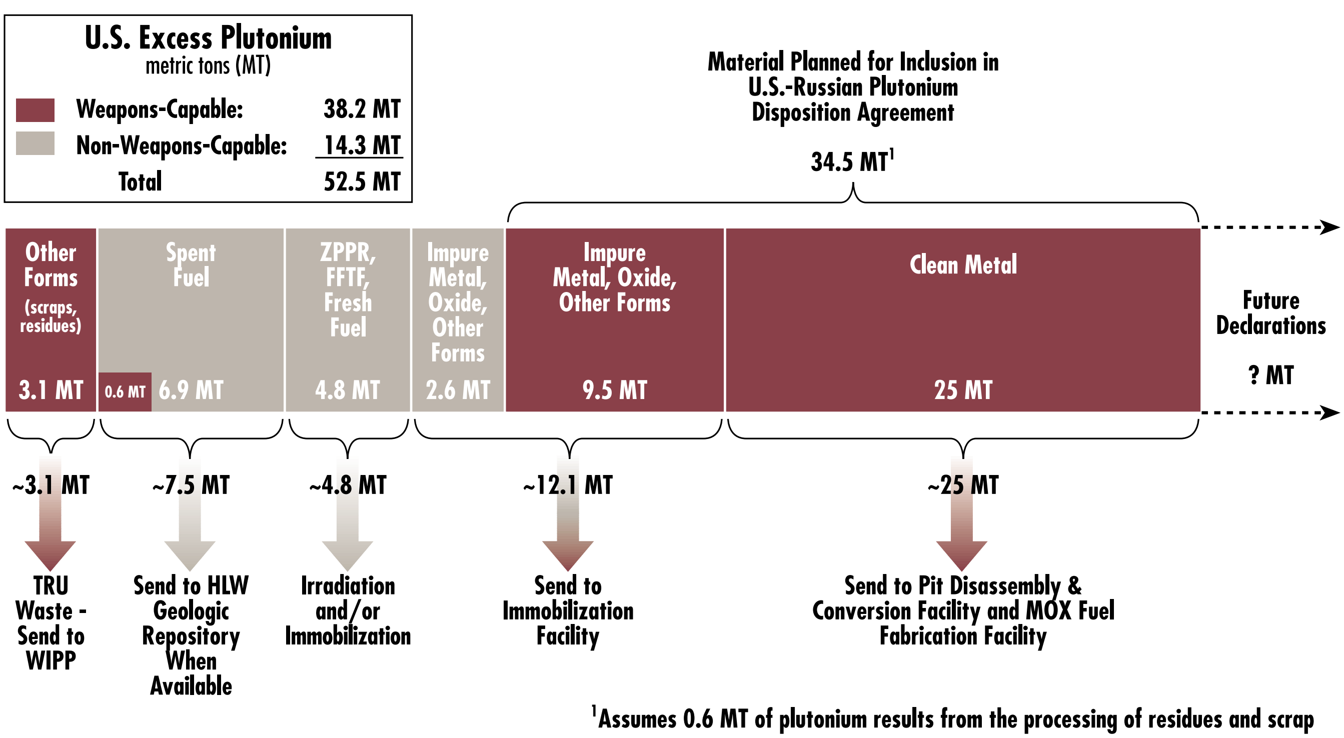


Figure 2-4 The Department's Plutonium Complex in the Year 2000

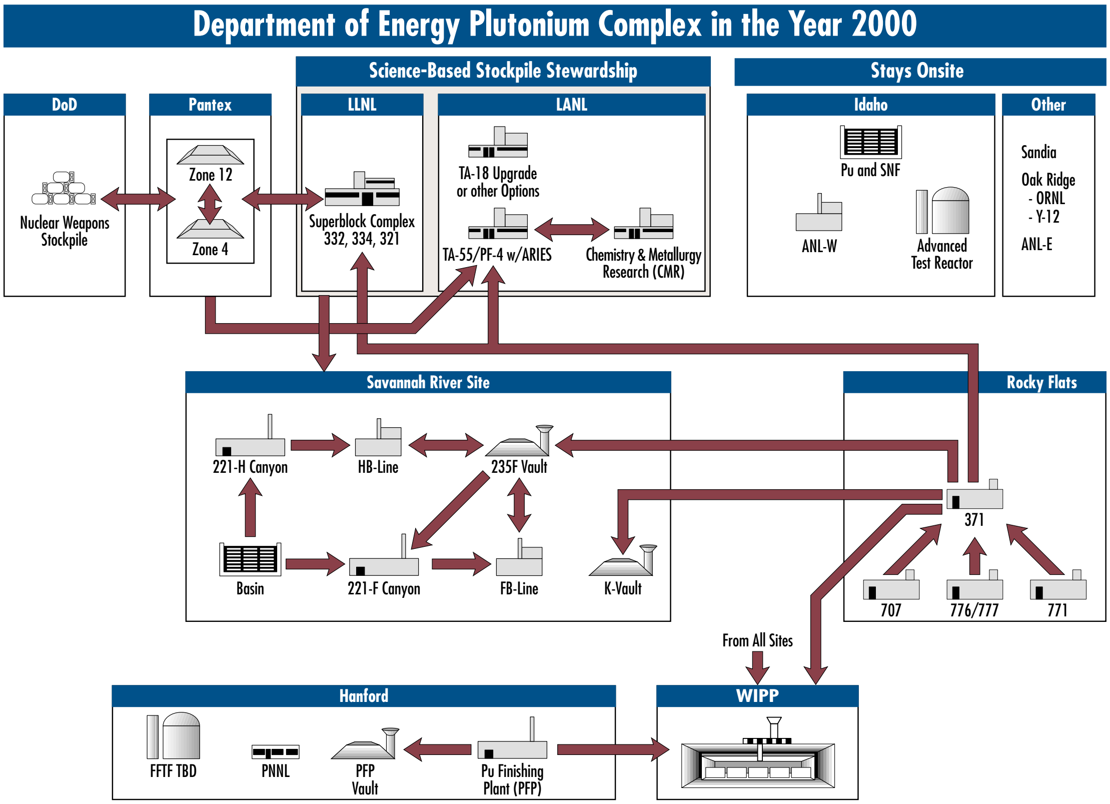
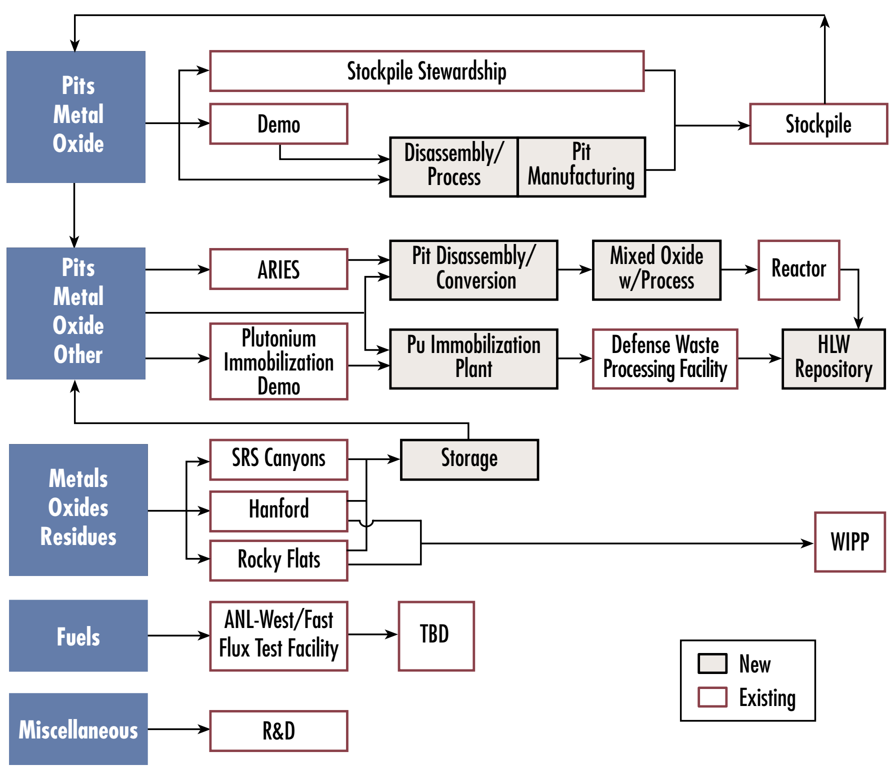


Figure 2-5
Representative Plutonium Baseline Disposition Pathways



Uranium

Overview and Inventories

Uranium is a slightly radioactive, naturally occurring element that is denser than lead. In its natural form, about 99 percent of the atoms in uranium have an atomic weight of 238, while less than 1 percent of the atoms have an atomic weight of 235. From the 1940's through today, the Department and its predecessor agencies used a process called gaseous diffusion to increase the proportion of U-235 in uranium, thereby enriching this material to an isotopic composition suitable for nuclear applications. Gaseous diffusion divides a stream of UF_6 gas, in its naturally occurring isotopic composition, into one stream enriched in U-235 and one depleted. Five to 10 kilograms of DU are produced for each kilogram of LEU and up to 200 kilograms of DU are produced for every kilogram of HEU.

Depleted Uranium Slugs

- *Highly-enriched uranium* (HEU) (equal to or more than 20 percent U-235) is used in weapons components and reactor fuels. Due to decreasing need, HEU production for the nuclear weapons program was discontinued in 1964 and it was discontinued for the Naval reactor fuel program in 1992. Of the Department's total current HEU inventory, 174 MT has been withdrawn from weapons programs and declared excess to national security. A small amount of the excess has programmatic use as blended-down fuel for research reactors. Half of this excess is stored at the Y-12 Plant at Oak Ridge.
- *Low-enriched uranium* (LEU) (less than 20 percent U-235) was used for production reactors and is now used as a replacement for HEU in domestic and foreign research reactors. At one time, the Department produced LEU for use in commercial nuclear power plants. However, in 1993, the United States Enrichment Corporation (USEC) assumed this responsibility. Most LEU is stored at Hanford, Paducah, and Fernald.
- *Depleted uranium* (DU) (depleted in the U-235 isotope) has been used for weapons parts, radiation shielding materials, as armor and penetrators by the military, and in a variety of commercial applications. Most surplus DU is in the form of DUF_6, stored in cylinders at the three gaseous diffusion plants.
- *Natural uranium* (NU) was obtained and stockpiled in substantial quantities to serve as a feed for enrichment processes. Most of the NU is stored at Paducah and Portsmouth.
- *Uranium-233* (U-233) is a manmade isotope resulting from the neutron capture of thorium-232 and has been used in weapons research and in reactor fuel programs. Most of the unirradiated U-233 is stored at ORNL as an oxide and at Idaho as fabricated Light-Water Breeder Reactor fuel (LWBR).

Baseline Program

The Department's policy is to eliminate where possible the stockpiles of HEU and ensure the highest standards of safety and accountability. The Department's uranium materials baseline program includes maintaining materials in safe interim storage (with stabilization and blend-down as needed) pending use/reuse in national defense or other programmatic applications or disposition as surplus uranium. The United States prohibits the production of HEU for nuclear explosives purposes or outside of international safeguards. The United States also makes fissile material no longer needed for our national security purposes available for safeguarding by the IAEA, consistent with plans for treatment, storage, and disposition. With respect to disposition of surplus uranium, the Department prefers to maximize the reuse of surplus uranium materials to the extent they meet (or can be processed to meet) specifications for use in the commercial nuclear fuel market. Plans for commercial use or disposal have been developed for surplus HEU in keeping with nonproliferation policies to minimize the civil use of HEU. Figure 2-6 depicts the excess HEU inventories by site. Evaluations are still in the early stages for determining potential disposition of U-233, LEU, NU, and other DU. The quantities of these materials are classified.

The overall management of the Department's excess uranium is accomplished through multiple Department programs, with the

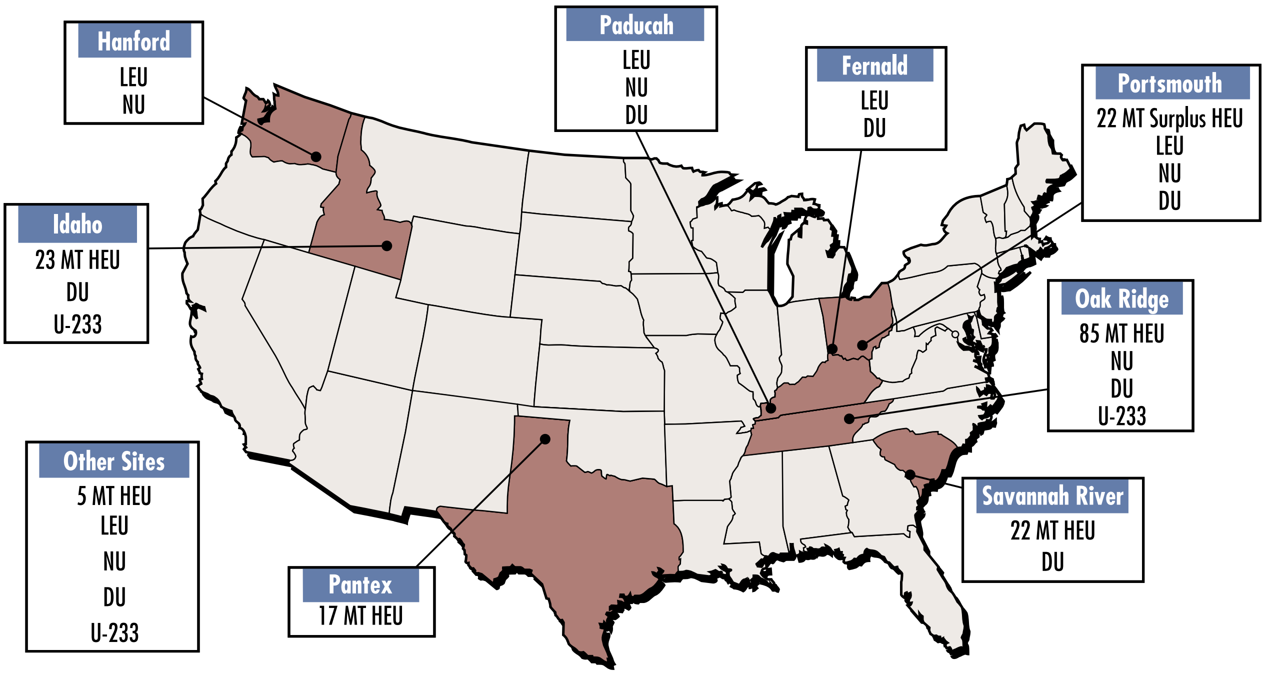


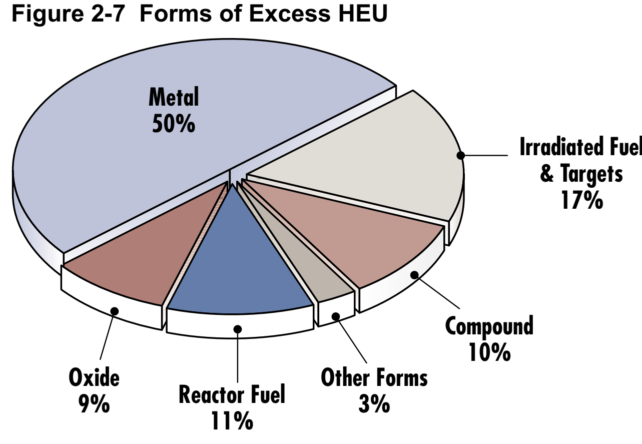
Figure 2-6 Excess HEU Inventories by Site (Based upon the Secretary of Energy's *Openness Initiative* Announcement of February 6, 1996.)

programmatic responsibility of HEU disposition residing with MD. Management of LEU/NU/DU is primarily the proposed responsibility of EM and NE, assisted by the Oak Ridge Uranium Management group. The management of U-233 is shared by DP, EM, MD, and NE. The management approach for each material type is discussed below.

Management Approach for HEU – The Y-12 Plant at Oak Ridge is the primary facility in the complex for storing and processing HEU, although significant quantities of surplus HEU are being processed at SRS and at two commercial facilities. Most of the national security, programmatic-use, and surplus HEU inventories are being consolidated at the Y-12 Plant. HEU is stored in secured and heavily protected vaults (a significant portion of the budget for HEU management and storage). Much will require processing before it can be reused. To support the consolidation, a new HEU Materials Facility is being planned. The facility would hold high quality HEU. Other forms, such as scrap, residue and fuel elements, would be stored elsewhere pending recovery of the HEU (Figure 2-7). A new Enriched Uranium Manufacturing Facility, not yet authorized, is in the feasibility study stage. This facility would be used for weapons program needs and would not have the capability and/or capacity to blend, process, or recover surplus materials. Upgrades to existing facilities to ensure safe operations have been identified.

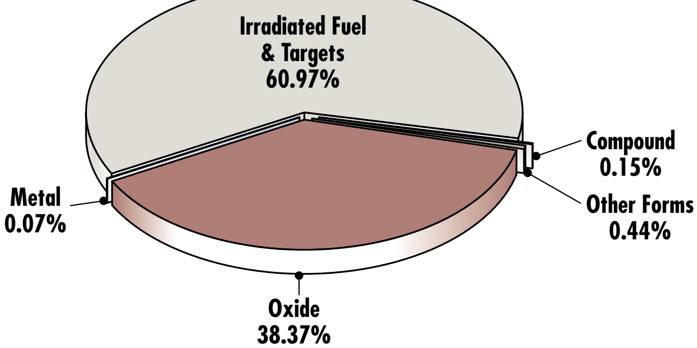
Under the 1996 Department Record of Decision on the disposition of surplus HEU (DOE, 1996c), the disposition strategy for HEU is to make it non-weapons-usable by blending it down to LEU for reuse as commercial reactor fuel (85 percent) or disposal (15 percent). Of the 174 MT of excess HEU, ownership of 62 MT of surplus material has already been transferred to USEC, including 48 MT that will be transferred over the next 6 years pursuant to the USEC Privatization Act (USEC, 1998) and the Memorandum of Agreement between USEC and the Department. An additional 30 to 40 MT of "off-specification" surplus HEU is planned to be transferred to the Tennessee Valley Authority (TVA) for use in its reactors. Of this material, approximately half would be down-blended at SRS and the remaining half at a licensed commercial vendor to be selected by TVA. The remaining quantity is undergoing additional evaluation to identify an appropriate disposition alternative.

Figure 2-7 Forms of Excess HEU



Management Approach for U-233 – The Department's inventory of separated U-233 is small relative to that of plutonium and HEU. However, the U-233 is weapons-usable and has stringent radiation protection requirements. Approximately half of the U-233 is stored at Oak Ridge. Most of this material is purified and of high isotopic quality, but is stored in a facility at Oak Ridge that requires upgrades to ensure continued safe storage. A similar quantity exists as a compound (with thorium) in fabricated LWBR irradiated/non-irradiated fuel elements. This material is stored at INEEL (Figure 2-8).

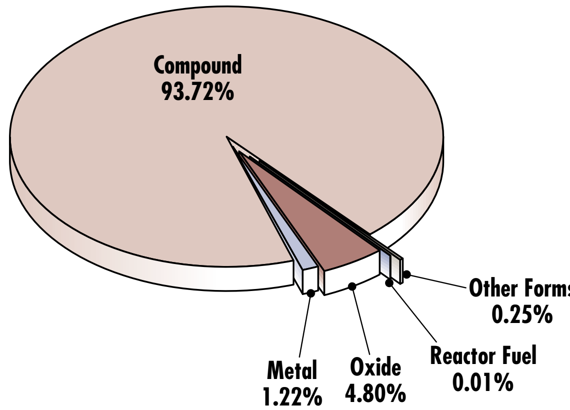
Figure 2-8 Forms of Uranium-233



In 1997, the DNFSB recommended that the Department clarify line responsibility for U-233 by establishing a single line item project to develop and implement a comprehensive plan for U-233, including the establishment of standards for U-233 packaging, transportation, and storage (DNFSB, 1997a, DOE, 1997c). A program is in place to remediate the near-term vulnerabilities and to evaluate the advantages and disadvantages of future management options. The Department is currently assessing what programmatic options will be evaluated in a future EIS. Options currently under consideration include preserving the high-quality U-233 as a national resource material for future use (e.g., decay to beneficial medical isotopes and R&D on proliferation resistant fuel cycles) and treating and disposing of the remaining material, depending on the results of economic studies for storage versus disposal.

Management Approach for DU – The Department maintains an active cylinder management program to improve existing storage conditions for the large inventories of DUF_6 at the gaseous diffusion plants. Under the Record of Decision for Long-Term Management and Use of Depleted Uranium Hexafluoride (DOE, 1999g), the Department will convert the DUF_6 inventory to uranium oxide, uranium metal, or a combination of both. The depleted uranium oxide form will be stored for potential future use. At this time, the Department does not believe that long-term storage or disposal as DU metal is reasonable, however, it is open to exploring these options further. The Department plans to issue a Request for Proposal (RFP) in FY 2000 for conversion services and to prepare an EIS on the construction and operation of conversion facilities.

Figure 2-9 Forms of Depleted Uranium



Smaller quantities of other forms of DU (Figure 2-9) currently have no formal, defined disposition path. Options for these materials will be evaluated as part of a future EIS on the management of potentially reusable uranium materials.

Management Approach for LEU and NU – LEU and NU are currently stored in a variety of forms and containers at multiple sites. LEU is used as fuel for domestic and foreign research reactors and NU is used as enrichment feed or for blending. While some quantities of LEU and NU have identified programmatic uses, other quantities are surplus and do not have defined disposition paths. Planning has been hampered due to insufficient characterization of these materials. Disposal of LEU is problematic in that compliance with enrichment limits at disposal sites could require extensive down-blending and packaging to meet transportation and disposal criteria. The infrastructure for such treatment is not in place, and a final path for disposition of this LEU has yet to be determined. For any end state, LEU may have to be stored temporarily until processing capacity is available. Restrictions on commercial sales and a depressed uranium market also present issues to the disposition of LEU and NU. A future EIS will evaluate the storage and disposition options for LEU and NU, including consolidation of usable inventories (Figures 2-10 and 2-11). Key uranium facilities are highlighted in Table 2-4.

Figure 2-10 Forms of Low Enriched Uranium

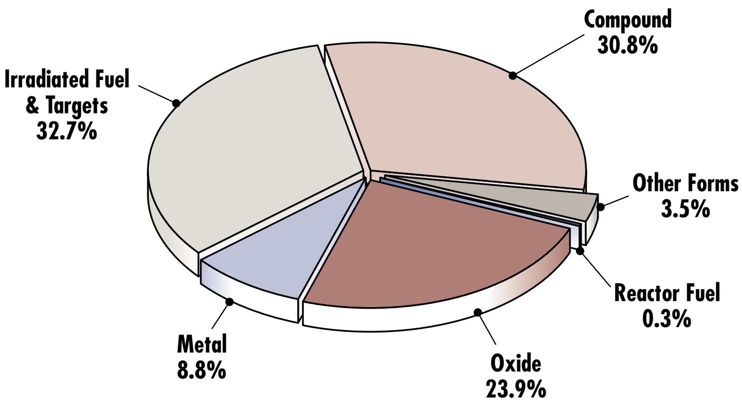


Figure 2-11 Forms of Natural Uranium

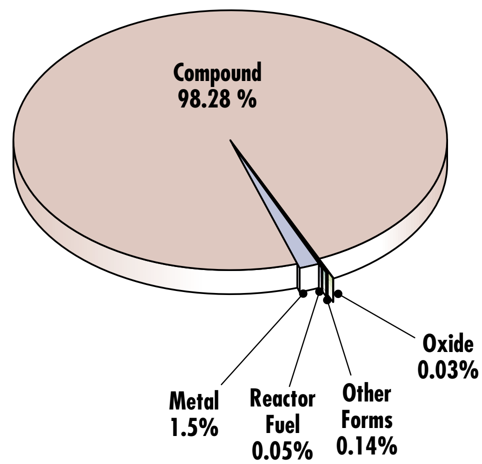


Table 2-4 Key Uranium Facilities

Facilities	Site	Functions	Status
New Highly Enriched Uranium Materials Facility	Y-12	Storage	– Propose to begin final design as FY 2001 budget line item – Construction planned FY 2001-2005 – On-line in FY 2005 – To be addressed in Y-12 Site-Wide EIS
Proposed Enriched Uranium Manufacturing Facility	Y-12	Chemical recovery, metal processing, down-blending	– Feasibility study underway – Projected construction beyond 2010 – Some funding provided under Y-12 Modernization Project
New DUF_6 Conversion Facility	Paducah/ Portsmouth	Conversion of DUF_6 to metal or oxide	– RFP for conversion services to be issued FY 2000 – Begin final design as FY 2001 budget line item – Proposed construction planned to begin FY 2002 – On-line in FY 2004 – To be addressed in DUF_6 Facilities EIS
Existing buildings: 9212, 9204-2E, 9215, 9720-5, and 9206	Y-12	Storage, packaging, processing	– 9000 series buildings recently out of stand-down status (stand-down has resulted in backlog of materials to be processed)
Radiochemical Development Facility (3019) Irradiated Materials Testing Facility (3025) Radiochemical Laboratory (4501)	ORNL	Storage	– Continue to store and treat Molten Salt Reactor Experiment primarily U-233 and store, inspect and repackage U-233 in accordance with DNFSB 97-1 Program Execution Plan (complete 2002)
F and H Canyons	SRS	Storage and processing of HEU solutions and irradiated targets and fuel elements	– F and H Canyons are being utilized to stabilize materials in accordance with DNFSB Recommendations 94-1 and 2000-1 Implementation Plans

Spent Nuclear Fuel

Overview and Inventories

Spent nuclear fuel is nuclear fuel that has been permanently withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing. Some irradiated targets are also managed as spent nuclear fuel due to their close similarity to reactor fuels and to their planned disposition in a geologic repository. The United States stopped reprocessing the Department's spent nuclear fuel for production purposes in 1992. The United States does not encourage the civil use of plutonium and, accordingly, does not itself engage in spent fuel reprocessing for either nuclear power or nuclear explosive purposes. Today, the Department's spent fuel is being stabilized, packaged for interim storage, and prepared for anticipated disposal in a geologic repository.

The Department currently manages about 2,500 metric tons of heavy metal (MTHM) of spent nuclear fuel (owned by the Department) at four sites: Hanford, Idaho, SRS, and Oak Ridge (Figure 2-12). Some small quantities of spent fuel are in storage at West Valley in New York and at the Fort St. Vrain site in Colorado. An additional 100 MTHM is expected to be received into inventory over the next 35 years, primarily from domestic and foreign research reactors and the Naval Reactors Program.

The Department's current inventory comes from: (1) its test and materials production reactors, (2) non-Department U.S. Government reactors, (3) U.S. university research reactors, (4) foreign research reactors, (5) U.S. Navy propulsion reactors, and (6) Department-owned commercial spent nuclear fuel. There are over 250 different fuel types that have different enrichment, fissile materials, cladding, and geometry. The major types and quantities are depicted in Table 2-5.

Table 2-5 Major Fuel Types and Surplus Quantity

Material	Surplus Quantity (MTHM)	Program
Spent Nuclear Fuel	2,494	
- Aluminum-based	10	EM
- Non-aluminum-based	21	EM
- Production Fuel/FFTF	2,115	EM/NE
- Department-owned Commercial	217	EM
- Sodium-bonded	61	EM/NE
- All Other	70	EM/NR

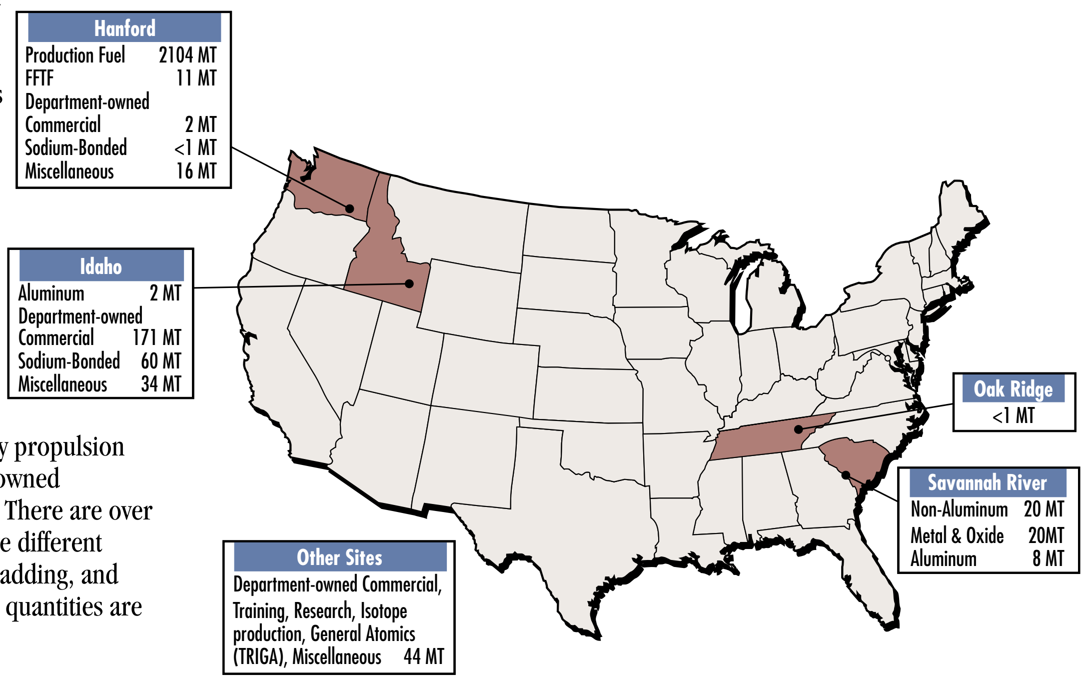


Figure 2-12 Spent Fuel Inventories by Site

Baseline Program

Much of the Department's spent fuel is stored in underwater basins (wet storage). Many of these basins are outdated; some spent fuel is corroded and could pose a risk in its current storage condition; and some fuel is not suitable in its current form for disposal in a repository (Table 2-6). Therefore, current programs and plans are focused on:

- correcting existing vulnerabilities,
- moving spent fuel from wet basins to dry storage,
- processing at-risk spent fuel, and
- preparing spent fuel in "road-ready" condition for anticipated future disposal in a high-level waste geologic repository.

Being "road-ready" means packaged inside a sealed canister that would be acceptable at a repository without having to be reopened at the time of shipment.

Pursuant to the Nuclear Waste Policy Act (NWPA) of 1982, as amended, the Department's RW is currently evaluating a site at Yucca Mountain, Nevada, as a possible location for a geologic repository. The Department is required by law to use a repository developed under the NWPA for disposal of HLW and spent fuel from national defense and civilian nuclear activities, unless the President finds that a separate repository for defense wastes is required. In 1985, President Reagan determined that a separate repository was not needed, and since then the Department has planned for disposal of its HLW from defense nuclear activities in a repository developed by RW. The role of a repository is central to Administration policy because the completion of a permanent geological repository is essential not only for commercial spent fuel disposal, but also for the cleanup of the Department of Energy's nuclear weapons complex and disposal of its weapons-capable materials. A repository also furthers U.S. international nuclear nonproliferation objectives.

Table 2-6 Current Approach for Storage and Preparation for Disposal of Spent Nuclear Fuel

Site	Approach
Hanford	• Move all spent fuel to new dry storage. • Place production fuel in Multi-Canister Overpacks pending shipment to a geologic repository. • Place FFTF fuel and other miscellaneous fuel in canisters for interim storage. Repackage for final disposition when repository acceptance criteria are finalized. [Note: The future use of FFTF is being evaluated under a range of potential options in an ongoing NEPA evaluation (DOE, 1999i). One option includes use of the facility as a candidate for isotope production and R&D missions. Another option is closure of the facility.] • Department-owned commercial fuel is already in road-ready form for shipment to a repository. • Store sodium-bonded fuel at FFTF until shipment to ANL-W for dispositioning with the balance of the sodium-bonded spent fuel.
INEEL	• Transfer aluminum-based fuel to SRS for interim storage. • Receive non-aluminum-based spent fuel from SRS and from domestic and foreign research reactors. • Close older wet storage facilities and transfer fuel to new dry storage. • Per agreement with State of Idaho, have all fuel in dry storage by 2023. • Dry and package all fuels in road-ready dry storage. No treatment beyond drying and characterization is anticipated. • Maintain sodium-bonded fuel in both wet and dry storage pending a Record of Decision on treatment and management of this material.
SRS	• Transfer non-aluminum-based spent fuel to INEEL for interim storage. • Receive aluminum-based fuel from INEEL and from domestic and foreign research reactors. • Maintain spent fuel in wet storage until treatment and storage facilities are brought online (pending NEPA review). • Aluminum-based spent fuel that poses health and safety concerns is processed using existing facilities; a small quantity of special fuels is proposed to be processed to prepare for disposition. • Pursue alternative technology development. Pending a Record of Decision, the planning basis is to melt and dilute all remaining aluminum fuel. (This would result in a homogeneous well-characterized waste form that would meet repository acceptance criteria.)

Decisions made in 1995 and 1996 (DOE, 1995a, 1995c, and 1996a) resulted in regionalized management of Department-owned spent nuclear fuel by fuel type. This regionalized approach to interim management of the Department's spent fuel (Table 2-7) consists of the following:

- Hanford production reactor spent fuel and selected commercial test and research reactor spent nuclear fuel will remain at Hanford.
- Non-aluminum-based spent fuel will be consolidated and stored at INEEL.
- Aluminum-based spent fuel will be consolidated and stored at SRS. Spent fuel posing health and safety risks is being processed.
- Naval spent nuclear fuel will be shipped to INEEL for examination and storage.

This approach is being implemented with foreign and domestic shipments being made to both Idaho and SRS. A major benefit of the regionalized strategy is that the interim storage sites are able to concentrate their resources on packaging and planning for disposition of spent fuel types for which they have unique management expertise.

The National Spent Nuclear Fuel Program, located at INEEL, provides centralized planning, inventory tracking, and quality assurance functions for the Department's baseline program. The Program is tasked with coordinating repository disposition efforts for Department-owned spent nuclear fuel and is working closely with RW to integrate Department-owned spent fuel into the preliminary repository design basis. A draft EIS has been prepared to consider the potential environmental impacts of developing, operating, and eventually closing a repository (DOE, 1999h).

In the meantime, the Department is working to resolve existing vulnerabilities and to package spent fuel in road-ready canisters for dry interim storage. With the exception of the small amount of spent nuclear fuel that is being processed at SRS, most Department-managed spent nuclear fuel would be directly disposed of in a geologic repository. Some may undergo treatment (melt and dilute), but the resultant waste forms would ultimately be disposed of in a repository (Figure 2-13).

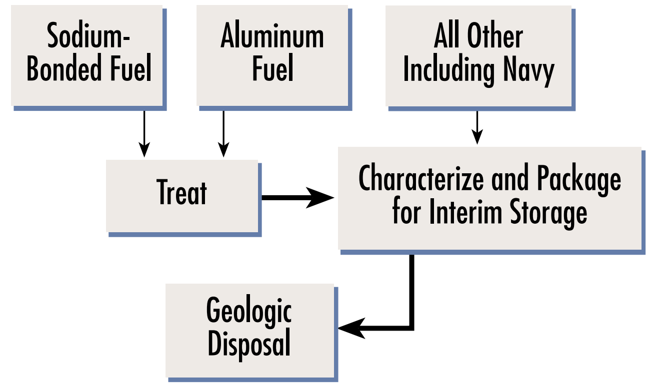


Figure 2-13 Spent Nuclear Fuel Disposition Paths

Fuels that do not meet repository acceptance criteria would need to be treated. The Department is working with the U.S. Nuclear Regulatory Commission (NRC) to receive its feedback on Department plans to prepare its spent nuclear fuel for disposal. This effort should minimize the risk associated with packaging of spent fuel for disposal prior to repository licensing. For planning purposes, it is assumed that shipments from the Department's three spent fuel management sites to a repository would take place during the 2010-2039 timeframe.

New storage/packaging/treatment facilities will be proposed to address spent nuclear fuel needs (see Table 2-7). These facilities will also be considered for other missions to maximize the Department's return on investment. One approach to maximizing the utility of any new facilities is by storing other HLW (e.g., vitrified HLW glass) in the same facilities. The Hanford Canister Storage Building, for example, has flexible capacity to store HLW glass logs in addition to the Multi-Canister Overpacks for which the facility was initially considered. The new facilities may be dry systems and either built to standards comparable to NRC regulations or as privatized facilities managed as NRC licensed facilities.

Table 2-7 Key Spent Nuclear Fuel Facilities

Facilities	Site	Function
Canister Storage Building	Hanford	Construction of the Canister Storage Building for dry storage of N-reactor spent fuel from the 105-K East and West basins is complete. Currently developing detailed plans for packaging other fuels for shipment to the repository.
Dry Transfer/Storage Facility	INEEL	Two facilities under procurement, one at the Naval Reactor Facility (Naval spent nuclear fuel), and a second facility at the Idaho Nuclear Technology and Engineering Center (non-Naval spent nuclear fuel).
CPP-603, CPP-666	INEEL	Existing wet storage pools; spent fuels are being transferred from the older, unlined CPP-603 facility to the newer, lined CPP-666 facility for interim storage pending eventual transfer to dry storage in the privatized Dry Transfer/Storage Facility.
Three Mile Island (TMI) Dry Storage Facility	INEEL	Thirty horizontal storage modules (HSM) have been completed; drying of canisterized TMI spent fuel is underway at the Test Area North facilities, with packages then transferred to the HSM for storage.
Fuel Conditioning Facility, Hot Fuel Examination Facility	ANL-W	Existing hot cell facilities; used in the demonstration program for the electrometallurgical treatment of sodium-bonded spent fuel; being evaluated under NEPA for the treatment of the remaining 60 MTHM of sodium-bonded spent fuels.
Irradiated Fuels Storage Facility	INEEL	Dry storage facility for storage of graphite spent fuel; expanded use for dry storage of spent fuels removed from vulnerable wet storage.
105-K/L Basins, Receiving Basin for Offsite Fuels	SRS	Current wet storage of production and research reactor spent fuels; some aluminum-based spent fuels are being processed.
Treatment and Storage Facility		Planning is ongoing (Record of Decision expected Spring 2000) that could result in modifying an existing reactor building to treat (melt/dilute) all remaining aluminum-based spent fuel.

Other Nuclear Materials

Overview and Inventories

The Department manages a variety of nuclear materials that are categorized for purposes of this document as "other nuclear materials." They include a variety of isotopes with applications including national security, nuclear energy, research and development, commercial use, and medical applications. Almost all Department sites, many universities, and private industry contributed to the development, production, and use of these materials.

For purposes of this Plan, the other nuclear materials are grouped into seven categories according to similarity in physical forms, radiation characteristics, safety and environmental risk, and interim and long-term management issues.

- *Special Isotopes* — This category includes isotopes produced in bulk and managed either as "strategic" isotopes or as useful byproducts from national security missions. Pu-238 and californium-252 are in continuing demand for use in radioactive heat and power sources and as medical and neutron sources, respectively. Neptunium-237, americium-243, and curium are feed materials for isotope production. The Department has more of these isotopes than it needs to support new isotope production in the foreseeable future. Small-quantity isotopes (berkelium-249, Pu-242, and other isotopes of californium, curium, and heavier elements) have continuing uses inside and outside of the Department in research and medicine. Naturally occurring isotopes (thorium-232 and radium-226) can be obtained commercially for future supply needs.
- *Large Beta-Gamma Materials* — This group is dominated by about 2,000 cesium/strontium sources (double-encapsulated), currently stored in wet basins at Hanford. Also included are sealed cobalt-60 irradiation sources and slugs, compounds of cesium and strontium, floor sweepings and scrap from source fabrication operations, and (at ORNL) a single strontium source containing nearly one million curies.
- *Actinide and Neutron Sources* — Approximately 1,400 actinide sources, with a total curie content of about 22,000 curies, are distributed across the complex. A considerable inventory of unsealed standards, samples, and small items are associated with research functions. About 1,000 sealed neutron sources also exist across the complex.
- *Other Sealed Sources, Standards, and Research Materials* — Small technical materials (sealed and unsealed sources, standards, research materials, etc.) make up this category. However, in terms of numbers of items in the "Other Materials Inventory," these materials represent approximately 25,000 of the 33,000 items inventoried. The majority are at the laboratories and former weapons production sites.
- *Thorium Materials* — A significant quantity (>100 MT) of surplus thorium metal and thorium oxide exists at 19 Department sites and a group of foreign and NRC licensees. The majority of the inventory exists at 3 sites and exceeds 10 MT each – Y-12, Sandia, and Idaho. Smaller quantities exist at EM sites that have near-term closure goals, such as Mound and Rocky Flats.
- *Light Nuclear Materials* — This group includes heavy water, tritium, and lithium. These are sensitive materials that are needed to support nuclear materials production. Heavy water was formerly used as a moderator/coolant in the Department's nuclear material production reactors. These reactors, and consequently, the heavy water production facilities, have been deactivated, as they are no longer needed to meet mission requirements. Much of the Department's remaining supply of heavy water is located at SRS. A small quantity of very pure stock is held at ORNL for research purposes.

  Although not a fissile material, tritium is a key component of all nuclear weapons presently in the nation's arsenal. Because of the relatively short half-life of tritium, long-term tritium supply and recycling capability will be required to maintain the weapons determined to be needed for national defense under the prevailing Nuclear Weapons Stockpile Plan. Production in one or more commercial light water reactors (LWR) will be the primary tritium supply source. An accelerator option is being developed, but not constructed, as a backup to commercial LWR tritium production as specified in the May 1999 Record of Decision (DOE, 1999f). Lithium is used as a target material for the production of tritium in the LWR approach.
- *Orphans* — This group includes materials, usually with unique physical or chemical characteristics, that fall outside the scope of established nuclear material management programs. Most are associated with Department reactors and include lightly irradiated or unirradiated fuels, subcritical assemblies, and reactor structural materials. The beryllium reflectors used by the Advanced Test Reactor at Idaho and the High Flux Isotope Reactor at Oak Ridge are a good example of orphan materials. Contaminated with tritium, these reflectors have an undefined disposition pathway.

Baseline Program

At present, there is no comprehensive assessment of these "other" materials. The Department has initiated the development of a Department-wide inventory and documented baseline plans for a number of the materials. For example, over 1,100 categories of materials have been identified. Baseline disposition paths have been established for about 60 percent of these. The remaining paths are "to be determined" and require additional analysis to establish disposition pathways. This effort will require continued momentum to produce a comprehensive inventory and to develop plans for all of the materials.

The approach for managing these materials varies depending on the material. As depicted in Table 2-8, disposition encompasses direct reuse, processing and refabrication, and storage while awaiting reuse or preservation as a national resource, disposal, or consumption (i.e., isotopes that are irretrievable or have short half-lives).

Continued Isotope Missions. To assess the Department's isotope needs, NE is preparing a PEIS to examine how the Department's nuclear facility infrastructure might be able to accommodate expanded civilian nuclear missions in the area of isotope production (medical and Pu-238, and research and development) (DOE, 1999i). The PEIS will include an evaluation of the possible restart of the FFTF at the Hanford site. The Draft PEIS is scheduled to be issued in mid-2000.

The potential demand for Pu-238 and its potential supply sources are major factors in NE's evaluation. Pu-238 is used in advanced radioisotope power systems for NASA space missions, and options are under consideration for establishing a Pu-238 production capability within the Department complex. This evaluation also includes options for storage facilities for the Np-237 inventory currently stored at SRS, since Np-237 is the source material required for Pu-238 production.

The Department lacks long-term storage capacity that can be reserved solely for other materials. For example, the bulk of SRS neptunium may be retained for future programmatic use. Storage, however, may span several decades before the actual use occurs. Interim storage of stabilized isotopes has the potential to impact missions to store excess weapons-capable fissile material. Capability needs are relatively straightforward, but the timing of the need for peak storage will interact with storage schedules and budget requests for enhanced capacity.

Table 2-8 Summary of Current Approach for Special Isotopes

Material Type	Strategy
Plutonium-238	• Continue national security support with self-contained DP capability. • Develop long-term production and infrastructure plan for future NASA needs (PEIS).
Neptunium-237	• Develop long-term program for storage and use, based on results of PEIS. Options include storage and fabrication of targets for Pu-238 production, storage as national resource, or disposal. • Stabilize SRS solutions and scrap as oxide for storage or later disposal.
Californium-252 and Other Heavy Isotopes	• Continue Oak Ridge heavy isotope production program. • Continue neutron source fabrication, reuse, and recovery program. • Consolidate surplus from discontinued operations in Oak Ridge.
Americium-243/Curium-244	• Stabilize SRS solutions as glass for storage or later disposal. • Continued storage of Mark18 targets at SRS pending future use/disposition decision.
Plutonium-242	• Continue national security support with self-contained DP capability. • Consolidate surplus from discontinued operations at Los Alamos.
Americium-241	• Continue to manage separated supplies under Isotope Production and Distribution office for sale or Department use. • Rely on commercial sector to provide supply and fabrication services to future customers. • Consolidate surplus from discontinued operations at Los Alamos.
Thorium-232	• Maintain low-level inventories to support Department energy programs. • Rely on commercial sector to provide supply and fabrication services to future customers. • Transfer surplus supplies to LLW programs for disposal.
Small-Quantity Isotopes	• Continue to provide irradiation services in Department research reactors and accelerators, relying on commercial sector for fabrication and disposal services. • Continue production and distribution of Certified Reference Materials to research institutions and industry. • Manage surplus from discontinued operations through Non-Actinide Isotope and Sealed Sources Management group.

Facility needs for isotope programs will depend heavily on future decisions (Table 2-9). The major functions that will be required include:

- production sources, including research and test reactors and accelerators;
- processing facilities to support small-scale recovery of produced isotopes, including Pu-238;
- isotope separation, chemical treatment, and fabrication facilities for Pu-238 power and heat sources, californium sources, Certified Standards, and some research materials;
- storage and transportation facilities; and
- waste treatment and disposal facilities.

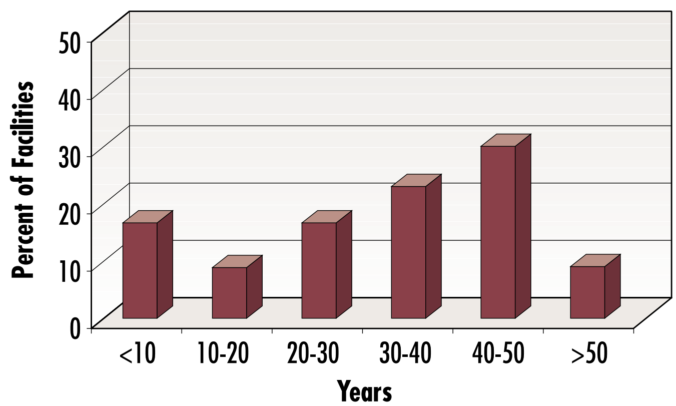
DP retains the capability for fabrication of parts needed for defense support and R&D. New capability for the fabrication of Pu-238 for radioisotope power and heat sources (replacing processes formerly performed at SRS) may be needed. The siting of this capability will be chosen under the PEIS (DOE, 1999i).

Table 2-9 Key Facilities for Other Materials

Key Facility	Site	Purpose	Status
Waste Encapsulation and Storage Facility	Hanford	Cesium and stronium storage	Operational
Tank Waste Remediation System	Hanford	Cesium and stronium vitrification	HLW vitrification scheduled to begin in 2009
F and H Canyons	SRS	Stabilization and packaging of bulk solutions	Operational
High Flux Isotope Reactor	ORNL	Isotope production	Operational
Radiochemical Engineering Development Center	ORNL	Research, storage, chemical processing of heavy isotopes	Operational
Resource Recovery	To be determined	Separate neutron sources	Pending site selection
Other Material Storage	To be determined - multiple sites	Store Department and commercial sources pending reuse, recovery, or disposition	Pending site selection
Hot Cells	Various	Support characterization and packaging operations	Existing at most sites where needed
Advanced Test Reactor	INEEL	Research, isotope production	Operational
Fast Flux Test Facility	Hanford	Research, isotope production	Reactor is on standby; future use is being evaluated in PEIS on isotope production missions

Crosscutting Considerations

Figure 2-14 Age Distribution of 90 Key Facilities



The infrastructure needed to manage nuclear materials is extensive and includes facilities utilization, technology development and deployment, and integrated transportation planning and execution. The following subsections describe the status of efforts in each of these crosscutting areas.

Facilities

The United States has a substantial investment in the facilities needed to manage its large inventory of nuclear materials. During the era of nuclear weapons production, the Department and its predecessor agencies built and used more than 20,000 facilities. Currently used or planned facilities are distributed at sites throughout the country (see Figure 2-15) and among many of the Department's program offices. Existing facilities are continually maintained, modified, or closed based on site or programmatic drivers. Site-specific decisions made for a particular facility or within a particular program may cause management and cost impacts for other sites or programs.

As shown in Table 2-10, the Department's material management needs have changed over the past decade from production of weapons material to treatment, storage, and disposition (i.e., programmatic use or disposal).

Table 2-10 Primary Processing Functions Over Time

Pre-1990	1990 to 2000	Post-2000
Production Reprocessing HLW storage LLW disposal Programmatic use	Storage Stabilization Remediation Characterization Repackaging HLW treatment Mixed/LLW treatment Programmatic use	Storage/Consolidation HLW disposal Spent Nuclear Fuel disposal Mixed/LLW disposal Processing/blending for commercial Light-Water Reactor fuel Programmatic use Nonproliferation activities

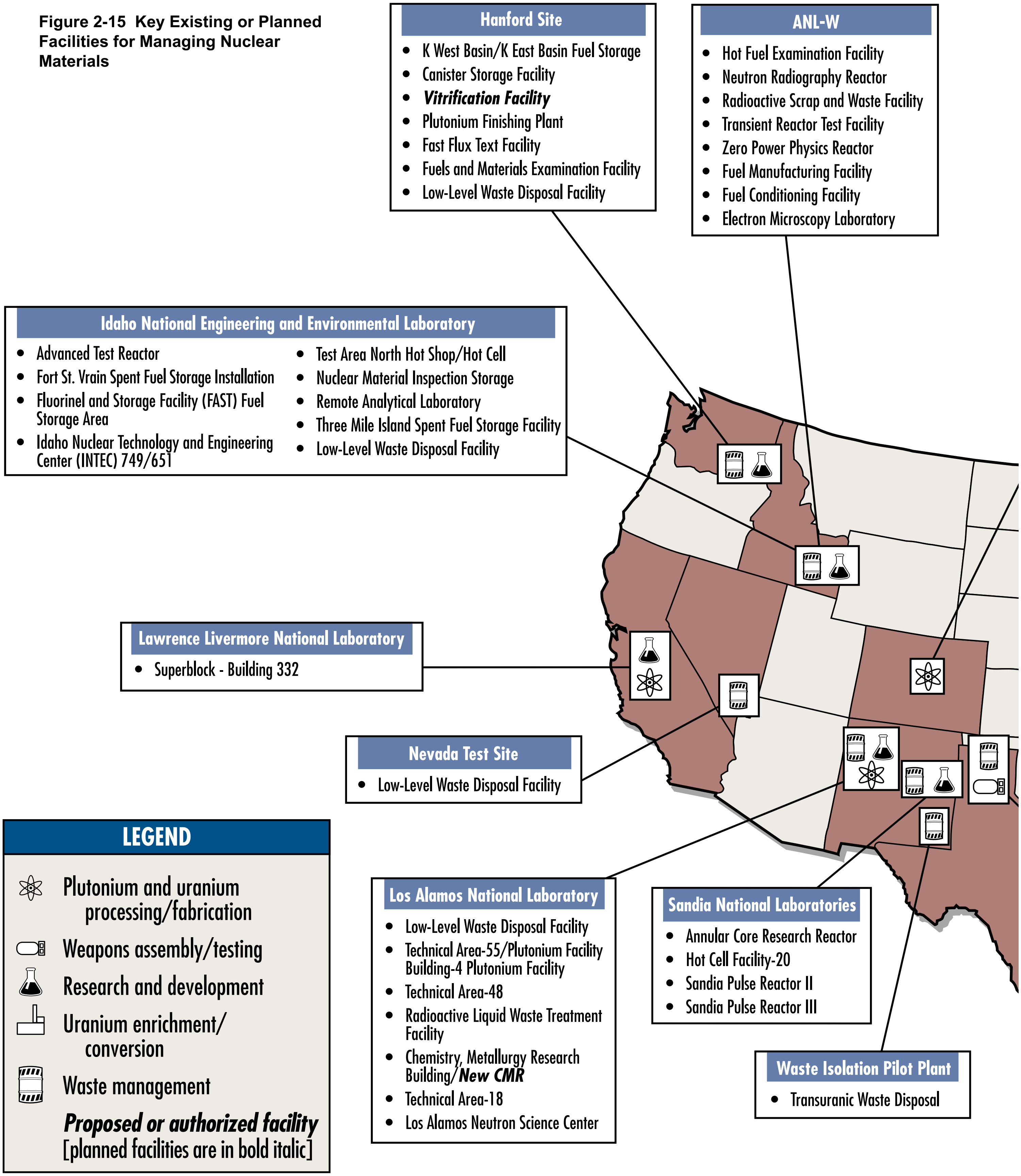
As represented in Figure 2-14, a recent analysis of over 90 key facilities in the Departmental complex indicates that about 60 percent have exceeded 30 years in age and about 10 percent have exceeded 50 years. Many of these facilities have met or exceeded their design life. This underscores the need to complete long-range planning to define future requirements.

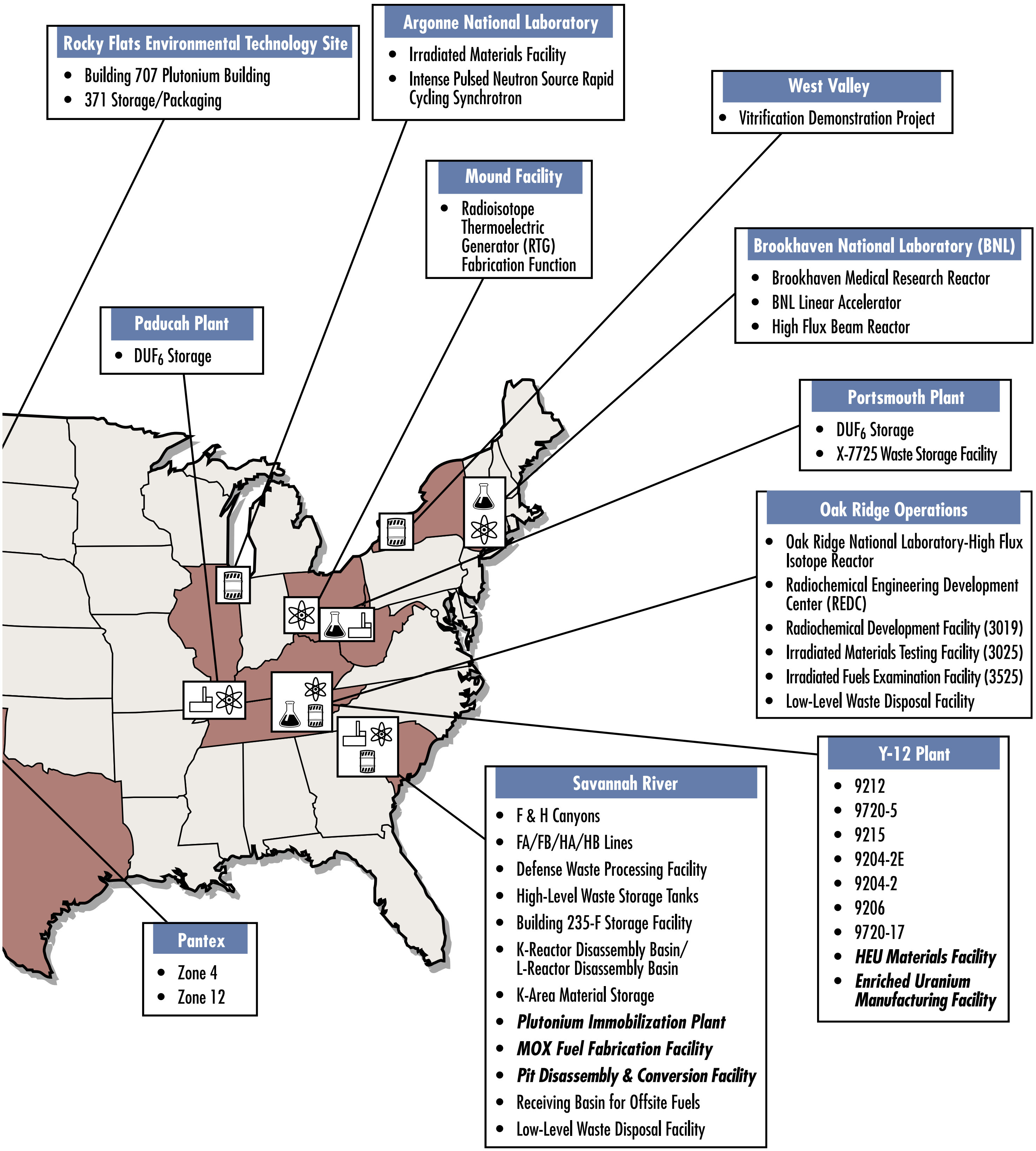
In response to DNFSB Recommendation 94-1 (DNFSB, 1994), an Integrated Facilities Plan was developed in 1995 (DOE, 1995e) to address the facilities issues associated with the stabilization of materials identified as being at risk. The Plan identified facilities required to stabilize at-risk materials and to provide for their safe storage and maintenance pending determination of ultimate disposition options. The Plan assessed the condition and issues associated with each identified facility and mapped the processing stream for each material. It also identified current initiatives and key decision points pertaining to stabilization and disposition of nuclear materials.

To provide further focus for the consolidation and disposition of nuclear materials, closure of facilities, and reduction of operating and maintenance costs, the Department has extended the scope of the Facilities Plan to cover nuclear materials facilities complex-wide. Although this work is continuing, several general observations can be made:

- **The Department's Infrastructure is Aged.** As Figure 2-14 demonstrates, the Department's infrastructure has aged. Countering this fact have been efforts to rebuild systems, modify/update facilities, and install new equipment. Life extensions for old buildings can address health and safety concerns, sometimes yield significant cost benefits, and allow for the continued use of facilities having unique structural/design features. On one hand, reusing old facilities makes sense for some functions. On the other hand, life-cycle cost analysis may show that investment in new facilities could prove to be the most fiscally prudent alternative.
- **Premature Closing Highlights Need for Integrated, Long-Term Planning.** Changes in mission resulted in several sites and about 5,000 surplus facilities being decommissioned during the 1990's. In some cases, events and conditions have caused facility closures prematurely

Figure 2-15 Key Existing or Planned Facilities for Managing Nuclear Materials




Rocky Flats Environmental Technology Site
• Building 707 Plutonium Building
• 371 Storage/Packaging
Argonne National Laboratory
• Irradiated Materials Facility
• Intense Pulsed Neutron Source Rapid Cycling Synchrotron
West Valley
• Vitrification Demonstration Project
Mound Facility
• Radioisotope Thermoelectric Generator (RTG) Fabrication Function
Brookhaven National Laboratory (BNL)
• Brookhaven Medical Research Reactor
• BNL Linear Accelerator
• High Flux Beam Reactor
Paducah Plant
• DUF_6 Storage
Portsmouth Plant
• DUF_6 Storage
• X-7725 Waste Storage Facility
Oak Ridge Operations
• Oak Ridge National Laboratory-High Flux Isotope Reactor
• Radiochemical Engineering Development Center (REDC)
• Radiochemical Development Facility (3019)
• Irradiated Materials Testing Facility (3025)
• Irradiated Fuels Examination Facility (3525)
• Low-Level Waste Disposal Facility
Y-12 Plant
• 9212
• 9720-5
• 9215
• 9204-2E
• 9204-2
• 9206
• 9720-17
• ***HEU Materials Facility***
• ***Enriched Uranium Manufacturing Facility***
Savannah River
• F & H Canyons
• FA/FB/HA/HB Lines
• Defense Waste Processing Facility
• High-Level Waste Storage Tanks
• Building 235-F Storage Facility
• K-Reactor Disassembly Basin/ L-Reactor Disassembly Basin
• K-Area Material Storage
• ***Plutonium Immobilization Plant***
• ***MOX Fuel Fabrication Facility***
• ***Pit Disassembly & Conversion Facility***
• Receiving Basin for Offsite Fuels
• Low-Level Waste Disposal Facility
Pantex
• Zone 4
• Zone 12

and those facilities could have, in retrospect, been used for processing surplus nuclear materials. For example:

– The Hanford PUREX facility was closed before processing more than 2,000 tons of irradiated N-Reactor fuel elements that were left, many damaged and all corroded, in the K-Area spent fuel basins.

– The Hanford Remote Mechanical Cell processing facility was closed, leaving significant quantities of solutions unprocessed at the Plutonium Finishing Plant (PFP). Some of these solutions remain unprocessed today and present problems for the Plant's deactivation project.

– The Oak Ridge Y-12 Plant low assay HEU processing facility, Building-9206, was placed in standby in 1994 before purifying the entire inventory of low-assay HEU material, leaving the Department complex with no facility for processing this material. Building-9206 is presently being deactivated.

– A number of hot processing cells have been closed, leaving the disposition of several thousand sealed sources largely undetermined.

These premature closings highlight the need for an integrated facilities planning process. One of the basic objectives of the integrated process will include development and implementation of a protocol for site closings. Among many other factors, the protocol will consider the influence of closings on the complex-wide functional capabilities necessary for the Department to accomplish its nuclear missions.

Today's nuclear materials management complex is increasingly expensive to maintain and operate. Old facilities continue to carry more of the main operating burden. Major decisions about replacing or upgrading critical facilities will be required within the foreseeable future.

An integrated facilities planning process is underway that will support the material management capability requirements of the future. This planning process will be assessed and redirected as needed to ensure that it is comprehensive, institutionalized, and:

- takes a systems approach that focuses on both current and future Department-wide functional requirements rather than on individual materials and program needs (this will move the complex in the direction of optimizing the use of existing facilities, assuring that future closures make "corporate sense," and maximizing the benefits to be gained from future facility investments);
- focuses on life-cycle planning that identifies the alternatives and costs of taking a material through to reuse or disposal (this includes sensitivity analyses to account for uncertainties);
- identifies capabilities of facilities now in the system and assesses their condition; and
- determines the need for new or replacement facilities to meet future requirements in a timely fashion.

Technology

Several Department documents outline technology requirements and R&D plans in support of its nuclear missions. Two documents that provide an integrated perspective on science and technology initiatives are the DOE Research and Development Portfolio (DOE, 1999j) and the Nuclear Science and Technology Infrastructure Roadmap (to be published Summer 2000).

In FY 1999, an R&D portfolio was prepared and has been updated for FY 2000, for each of the Department's four strategic business lines: energy resources, environmental quality, national security, and science. These portfolios define the R&D needs that must be met to accomplish the strategic program goals of the Department. Each business line portfolio integrates the capabilities, policies and requirements of all the Department's programs and laboratories relevant to that business line. Technology roadmapping is being instituted as a planning and decision tool to develop and execute a balanced R&D portfolio in future years.

The Department manages a substantial infrastructure of nuclear science and technology assets that are used for conducting both technology-directed and basic nuclear science research. Many of these assets have been shut down or placed in prolonged standby, while others are operating at or near full capacity. To ensure that the Department has adequate facilities in place to meet future nuclear mission requirements, NE has initiated the development of an infrastructure roadmap. The first phase of this effort produced a draft roadmap, which will be published shortly, of the nation's nuclear R&D infrastructure against likely science and technology requirements through the year 2020 for isotopes, space, nuclear power technology, general nuclear science, and national security missions. Subsequent roadmaps will include the consideration of MD and EM and will conform with the Department's nonproliferation policy.

The Department's science and technology efforts address only the unique mission needs of its principal organizations based on needs assessments and development plans. The mission-specific science and technology initiatives for the various organizations are:

- **Defense Programs**. Technology requirements for the Science-Based Stockpile Stewardship include developing a fundamental understanding of nuclear materials properties, aging phenomena, and high-pressure behavior.

Key Documentation of Departmental R&D Requirements and Plans

Research and Development Council

- Departmental Research and Development Portfolio

Defense Programs/National Security

- DP Enhanced Surveillance Program
- DP Plutonium Strategy
- The Nuclear Infrastructure to meet National Security Requirements

Environmental Management

- EM Strategic Plan for Science and Technology
- EM R&D Program Plan
- Nuclear Materials Focus Area FY 2000 - FY 2004 Multi-Year Program Plan
- Nuclear Materials Focus Area Needs Listing
- Integrated Spent Nuclear Fuel Technology Needs List
- Spent Nuclear Fuels Focus Area Needs Listing
- EM Science Program Needs by Focus Area

Fissile Materials Disposition

- Pit Disassembly and Conversion R&D Plan
- Plutonium Immobilization R&D Plan

Nuclear Energy, Science and Technology

- Nuclear Energy Research Advisory Committee: Long-Term Nuclear Energy Research and Development Plan (October and December Workshop Reports)
- Nuclear Energy Research Initiative
- Nuclear Science and Technology Infrastructure Roadmap
- Notice of Program Interest: Exploratory/ Developmental Programs for Uses of Isotopes in Medicine

Science

- Strategic Plan of the Office of Science

Subcritical experiments are used to benchmark computer simulations and work is ongoing to study the effects of weapons component remanufacturing techniques.

- **Environmental Management**. Science and technology initiatives include developing techniques to stabilize materials, developing technical bases for storage standards, developing approaches for surveillance of stored materials, and developing a more comprehensive understanding of the underlying science of material behavior in storage and transportation environments.
- **Fissile Materials Disposition**. Technology initiatives include automation for dose reduction, decontamination and declassification of components, feed preparation, ceramic formulation, and material characterization.
- **Nuclear Energy, Science and Technology**. Technology initiatives include proliferation-resistant reactor and fuel development, technologies for storage of nuclear waste, fundamental nuclear science and technology, and space power systems.

As the Department proceeds with efforts to ensure an enduring technology infrastructure to meet program needs, complex-wide integration of its R&D efforts will be undertaken to reduce overlapping efforts and optimize existing capabilities of the sites and program offices.

Transportation

Current transportation efforts within the Department are undertaken on a material-specific and program-driven basis. National security shipments use the Department's Transportation Safeguards System, while non-national security shipments are undertaken via Departmental, NRC, or commercial shipping regimes. As the numbers of shipments increase in the coming decades, greater integration effort will be essential. For example, a 28-year shipping campaign would involve moving up to 4,000 canisters of spent fuel to a geologic repository. The National Spent Nuclear Fuel Program is in the initial planning stages for a rail-based transportation system designed to move road-ready packages of spent nuclear fuel to a repository under NRC regulations. Several initiatives are planned and are discussed further in Chapter 3.

Life-Cycle Planning

In order to effectively integrate its nuclear material missions, the Department must complete planning for all nuclear materials through each material's full life-cycle ending in its final disposition (irradiation, separation, storage, reuse/ disposal). The Department has been successful in identifying its nuclear material inventories and in determining disposition paths for a large portion of these materials. Prior planning efforts have focused on functions occurring early in a material's life (production, transportation and storage) and have not always sought to complete the disposition picture. The Department will complete baseline disposition plans for the remaining portion of the inventory. This effort continues as an integral part of the NMSI.

Budget

The Department manages its nuclear materials through 8 major program offices at 36 different locations. Managing (i.e., safely processing, stabilizing, packaging, storing, monitoring, transporting, and disposing) such a wide variety of material types at such diverse sites comes at no small cost to the taxpayer. The exact amount is difficult to capture because the Department structures its budget around direct program missions. Depending on the program, the costs of activities associated with managing nuclear materials, such as information technology or landlord costs, may or may not be separately identified in the budget.

As such, the percentages presented in this section are based on an estimate of the annual cost of managing excess nuclear materials. These estimates do not account for safeguards and security costs nor for the costs associated with implementing the transparency provisions of our international nonproliferation agreements. A more detailed and comprehensive review will be conducted before the Department can confidently provide more complete costs of managing its nuclear materials.

Nuclear materials management costs for each nuclear material category are segmented in two ways: by program and by material management function. Figure 2-16 presents the relative distribution of costs across material types. Figure 2-17 provides a picture of the distribution of materials categories by program and function.

Figure 2-16 Excess Nuclear Materials Management by Material Type (presented as a percent of the total estimated cost of managing excess nuclear materials)

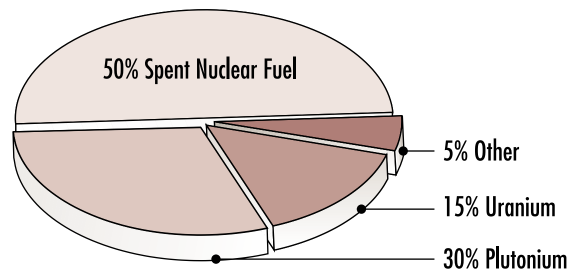
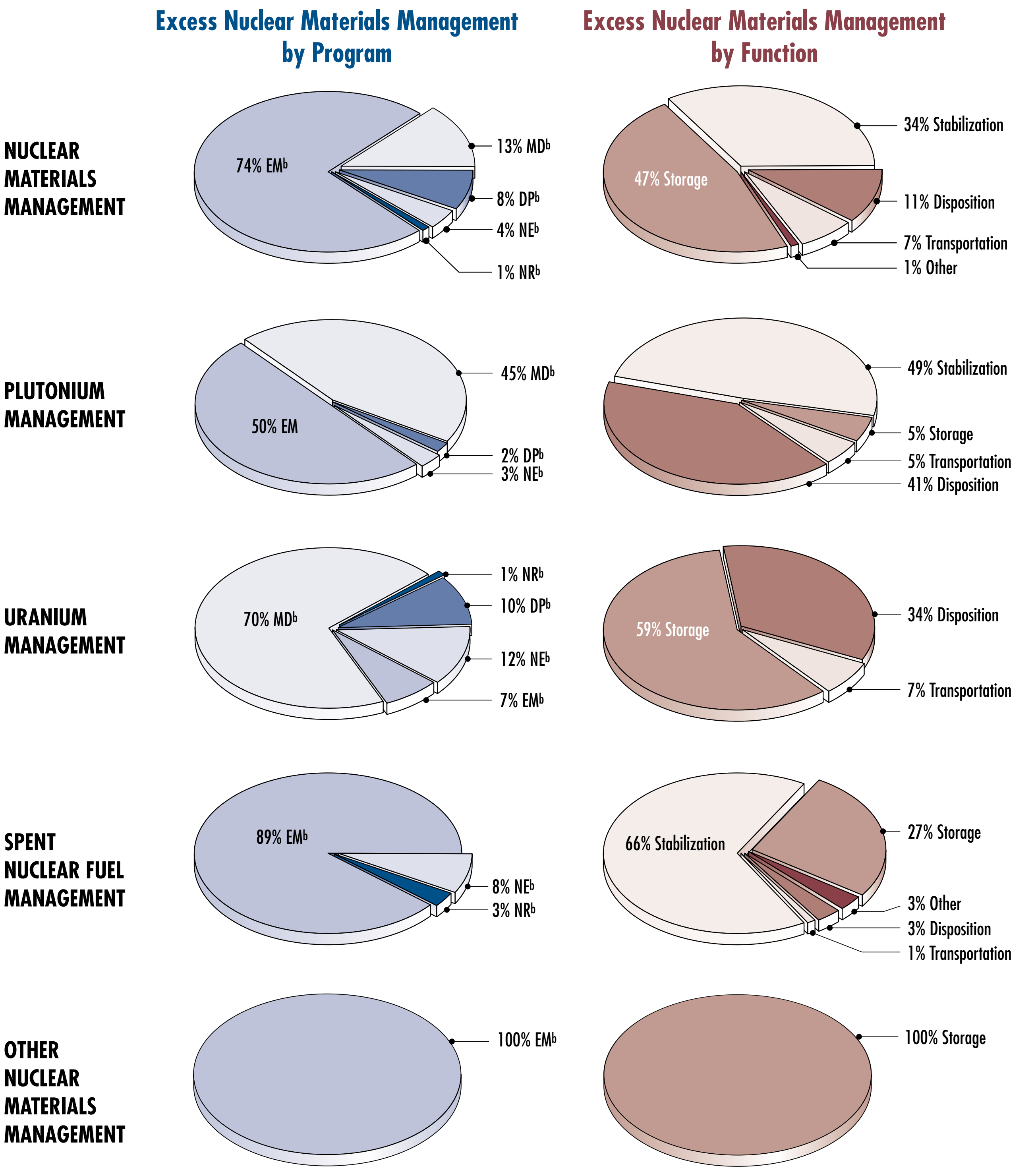


Figure 2-17 Estimated Annual Cost of Managing Excess Nuclear Materials (by Program and Management Function[ab])



a Based on preliminary ROM FY 2001 budget, including capital and operating costs.

b Does not include all nuclear material management costs from RW, NN, and SC.